P-21

Ferromagnetic Resonance of RF Magnetron Sputtered Fe-Si_3N_4 Thin Films

W. K. Kang* and W. Y. Lim
Department of Physics, Korea Univ., Chochiwon 339-700, Korea
J. S. Baek
Institute of Science and technology, Korea Univ., Chochiwon 339-700, Korea

I. Introduction

Recently, with a further demand for the miniaturization of electromagnetic devices, many researches are under way to develop thin films exhibiting good magnetic properties up to 100 MHz [1,2]. In particular, granular films consisting of metallic magnetic grains and intergrains with very high electrical resistivity are of great interest, because they possess very high electrical resistivity in a form of single layered film. In this work, we have investigated standing spin wave properties of Fe-Si_3N_4 thin films fabricated by an RF magnetron sputtering system using a composite target. Exchange stiffness constant, spectroscopic splitting factor, saturation magnetization are calculated from the spin wave spectra of the samples.

II. Experimental

Fe-Si_3N_4 thin films have been deposited on the pre-cleaned corning glass substrate by RF magnetron sputtering system using a composite target. The target consisted of an Fe disc with 100 mmΦ in diameter and small pieces of Si_3N_4. The background pressure was lower than 7.0×10^{-7} Torr and argon with purity 99.999 % was used as a sputtering gas. The sputtering pressure was 1 mTorr and the input power was 300 W. The thicknesses of samples were changed in the range of 30 nm to 300 nm. They were controlled by adjusting the sputtering time and measured by surface profiler. In order to measure the standing spin wave spectra of the films, ferromagnetic resonance experiments had been performed in the frequency of ~9.44 GHz at room temperature.

III. Results

Figure 1 shows spin wave derivative absorption spectra for various thick films at perpendicular resonance. Where the curves of gain 1 and 50 are represented with filled (●) and unfilled circles (○), respectively. Only uniform mode was observed in the spectra for

30 nm thick sample. It is supposed that the sample was so thin that the condition for standing spin waves were not satisfied. Several spin waves were found for 60 nm thick or thicker ones. Thicker samples had more spin waves. The spin wave derivative absorption spectra were analysed after the followong resonance condition [3].

$$\left(\frac{\omega}{\gamma}\right)^2 = \left[H - 4\pi M_s \sin^2\phi_H + \frac{2A}{M_s}\left(\frac{n\pi}{t}\right)^2\right]\left[H + 4\pi M_s \cos 2\phi_H + \frac{2A}{M_s}\left(\frac{n\pi}{t}\right)^2\right] \quad (1)$$

where $\gamma\,(=ge/2mc)$ is the gyromagnetic ratio, g the spectroscopic splitting factor, H the resonance field, M_s saturation magnetization, ϕ_H the angle between the applied DC field and the film plane, A exchange stiffness constant, n mode number and t film thickness. Spin wave modes of both odd and even number were identified after analysis of Fig.1 with eq.(1). Intensity of even number spin wave much weaker for the 60 nm thich sample, but it increased with increasing film thickness. It is expected that the difference of surface magnetic anisotropies between the both sides increased as sample thickness increases. The saturation magnetization, the spectroscopic splitting factor and exchange stiffness constant remained almost constant for samples thicker than 60 nm.

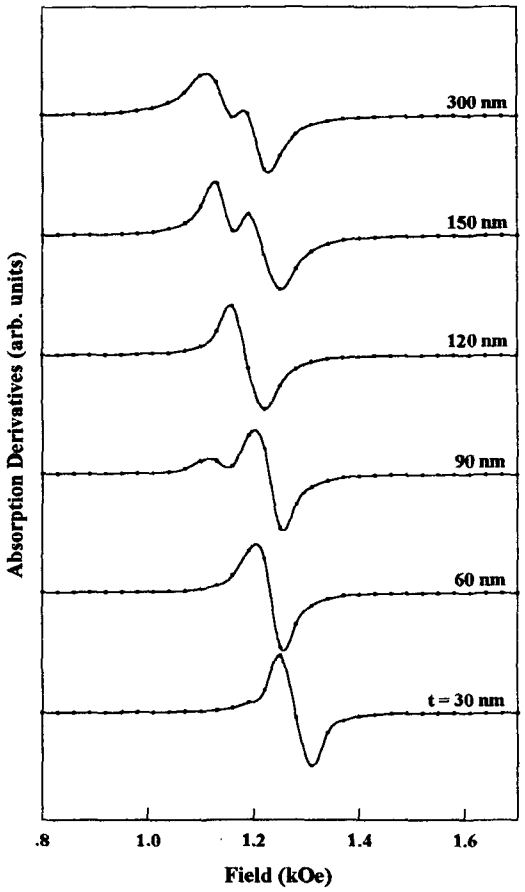

Fig.1 Spin wave derivative absorption spectra for Fe-Si_3N_4 thin films at perpendicular resonance.

References

[1] C. L. Chien, S. H. Liou and Gang Xiao, J. Mag. Mag. Mat. **54-57**, 759(1986).

[2] S. Mitani, H. Fujimori, S. Furukawa and S. Ohnuma, J. Mag. Mag. Mat. **140-144**, 429(1995).

[3] C. Kittel, Phys. Rev., **110**(6), 1295(1958).